

## PREDICTORS OF POSITIONING ERROR IN DIGITAL RADIOGRAPHY

Waseem Akhtar,<sup>1</sup> Munawar Hussain,<sup>3</sup> Mubashir Aslam,<sup>2</sup> Arif Ali,<sup>2</sup> Abida Faisal<sup>1</sup><sup>1</sup> Department of Radiology, The Aga Khan University Hospital, Karachi, Pakistan.<sup>2</sup> Department of Radiology, Dow University of Health Sciences, Karachi, Pakistan.<sup>3</sup> Department of Radiology, Patel Hospital, Karachi, Pakistan.

PJR July - September 2011; 21(3): 102-106

## ABSTRACT

**OBJECTIVE:** To determine the factors responsible for the occurrence of film retakes by positioning error in digital X-ray radiography. **STUDY DESIGN:** cross-sectional. **PLACE AND DURATION OF STUDY:** Department of radiology aga Khan University and Patel hospital Karachi from January to August 2009. **METHODS:** X-rays of different body parts conducted during the study period at Aga khan hospital (n=45886) and in Patel hospital (n=7510) with digital radiography were included in this study (n=53396). Measurements were done for number of X-rays retake due to different quality control reasons in digital radiography. Quality control reasons included positioning errors and others (underexposure, over exposure, patient movements, grid cut off and equipment related) due to which X-ray quality was questionable. Radiographer (age, gender and radiographic experience) and patient related factors (age, gender, condition of patient and area of X-ray examined) that might cause X-ray retake in digital radiography were also evaluated. Multivariate logistic regression was applied to identify the significant predictors of positioning retake in digital radiography. **RESULTS:** A total of 670 (1%) digital X-ray radiographic examinations were observed where film retakes were performed due to positioning and other errors. More than half (57%) of the all films retakes were due to Positioning error alone. Multivariate analysis had shown that radiographic examinations by male radiographer decrease 35% risk of occurrence of positioning occur in digital radiography (C.I.=0.47-0.9). Increase in the patient age and male sex of the patient were at significantly higher risk of causing positioning error as compared to other errors for film retakes (p-value <0.0001). Similarly other parts of body examinations were 2.3 times higher risk of producing positioning error as compared to abdominal examinations by digital radiography (C.I.=1.7-3.3). **CONCLUSION:** Patient age, examination of parts of body other than abdomen, male patients and the digital X-ray radiographic examination performed by a female radiographer are the significant factors responsible for film retake due to positioning error.

**Key words:** Digital; Positioning error; Retake; Radiography.

## Introduction

Digital radiography has been introduced as a replacement for conventional film based radiography in many parts of the World.<sup>1-3</sup> Although digital radiography has proven to be safer and feasible for performing quicker process with better result in the presence of wide range of body parts vision.<sup>4</sup> Yet cost of the technology may obstruct its fast growing implementation in developing countries with limited resources. Nevertheless cost of the digital technology

has been rapidly decreasing since the past few years.<sup>5</sup> In spite of having benefit of quicker image transfer, digitally transferable and storage of data, higher radiation dose is required in digital radiography to achieve same resolution as compare to conventional radiography.<sup>6</sup>

Hence film retakes in digital radiography increases further unnecessary radiation exposure and should be reduced to minimum. Digital radiography has shown a tremendous decrease in film retakes rate as compared to conventional radiography.<sup>7</sup> However position error has been appeared to be the most frequently occurrence error for film retakes in digital

**Correspondence :** Dr. Waseem Akhtar,  
Department of Radiology,  
Aga Khan University Hospital,  
Stadium Road, P.O Box 3500, Karachi, 74800.  
Tel. No. 4930051-5606  
E-mail: waseem.mirza@aku.edu

radiography.<sup>7</sup> As high as 30% of all retakes were due to positioning error in an evaluation study of digital radiography. Other studies have also reported it to be the major reason for repeat procedure in digital radiography and linked it to the skills of the radiologists.<sup>8</sup> Same study also revealed that although retakes were decreased in the digital radiography, the proportion of positioning errors was actually increased as compared to conventional radiography. Evaluation of the factors responsible for such high proportion of positioning error in digital X-ray radiography is needed further exploration and no study has been published to address this issue. Hence the objective of this study was to identify patients and radiographers' factors responsible for the occurrence of positioning error in digital radiography.

## Material and Methods

Data was collected in the department of radiology Aga Khan University Hospital and Patel hospital Karachi from January 2009 to August 2009 to include x-ray examinations of different body parts by using digital radiography. By taking the 30% occurrence of positioning error in digital radiography<sup>7</sup> and  $p=0.3$ ,  $q=0.7$ ,  $B=0.05$  and  $Z=1.96$  a total of 323 sample size would be sufficient to achieve the objective of study. Measurements were done for number of X-rays retake due to different quality control reasons in digital radiography. Quality control reasons included positioning errors and others (underexposure, over exposure, patient movements, grid cut off and equipment related) due to which X-ray quality was questionable. Age, gender and radiographic experience of radiographer who did the X-ray and patient related factors include age, gender, condition of patient and area of X-ray examined (chest, abdomen, limbs and skull) that might cause X-ray retake in digital radiography were also evaluated. Patients underwent more than one body part X-rays simultaneously were excluded from this study. All radiographs were performed on referring physician's written request and no X-ray exposure was given unless justified clinically by using standard radiation protection measures. All digital images were evaluated in prespecified display monitors with facility of post processing. A panel of two experienced radiographers supervised by certified radiologist checked the image quality and if needed repeat X-ray was done. Data collectors were trained and were given predefined data collection sheet for number and factors responsible for retake X-rays. Data was entered in Microsoft Excel. Analysis was

done in SPSS version 16. Multivariate logistic regression was applied to identify the significant predictors of positioning retake in digital radiography. p-value less than 0.05 were considered significant.

## Results

A total of 670 (1%) digital radiographic examinations were observed where film retakes were performed due to positioning and other errors. Radiographer and patients' characteristics are presented in (Tab.1). Around half of the radiographers were male (51%) and 49% had radiological experience greater than 5 years. More than half (57%) of the all films retakes X-ray were due to Positioning error alone. Most of the patients were of normal built in whom film retakes had to be done as a result of some error. However 23% of the patients were obese and around 21% of patients were not able to walk due to physical disabilities. Larger proportion (58%) of the participants was male. Out of 670 sample of film retakes, 344 (51%) were involving abdominal examination (Tab.1).

Variables	n	%
<b>Radiographer's gender</b>		
Female	327	48.8
Male	343	51.2
<b>Experience of Technology (years)</b>		
< 5	335	50.1
≥ 5	334	49.9
<b>Positioning Error</b>		
No	285	42.5
Yes	385	57.5
<b>Patient age(years)</b>	(Mean: SD)(38:20)	
<b>Patient gender</b>		
Female	280	41.8
Male	390	58.2
<b>Patient Built</b>		
Normal	493	73.6
Obese	177	26.4
<b>Status of Patient</b>		
Walking	533	79.6
Not able to Work	137	20.4
<b>Type of Exam</b>		
Chest / abdomen	344	51.3
Others	325	48.5
<b>SD; Standard Deviation</b>		

**Table 1:** Frequency distribution of characteristics of radiographer and patients who received the radiography (n= 670).

In (Tab.2) univariate binary logistic analysis has been shown to report that radiographic examination by male radiographer had 25% lesser chance of causing positioning error as compared to female radiographer with insignificant confidence interval (C.I= 0.5 - 1.1; p-value=0.059). Similarly increase in the age of the patients also increased the risk of occurrence of X-ray retakes due to positioning error (p-value= 0.001). In addition, positioning error occurred 1.5 times higher in male patients as compared to the female patients (C.I=1.1-2.2; p-value=0.005).

Variables	OR	95%CI	p-values
<b>Radiographer's gender</b>			<b>0.059*</b>
Female	1		
Male	0.7	0.54, 1.1	
<b>Experience of Technology (years)</b>			<b>0.9*</b>
< 5	1		
≥ 5	0.99	0.7, 1.3	
<b>Patient Built</b>			<b>0.76*</b>
Normal	1		
Obese	0.94	0.67, 1.3	
<b>Patient age(years)</b>	<b>1.01</b>	<b>1.005,1.021</b>	<b>0.001</b>
<b>Patient gender</b>			<b>0.005</b>
Female	1		
Male	1.56	1.1, 2.1	
<b>Status of Patient</b>			<b>0.88*</b>
Not able to Work	1		
Walking	1.03	0.7, 1.5	
<b>Type of Exam</b>			<b>&lt;0.001</b>
Chest / abdomen	1		
Others	2.02	1.4, 2.7	

OR; Odds Ratio  
CI; Confidence Interval  
p-value < 0.05 was statistically significant  
\*; variable is not statistically significant

**Table 2:** Univariate analysis of logistic regression with radiographer and patients related characteristics' positioning error as an outcome variable.

Other body part examination process was also twice as likely to cause positioning error as compared to abdominal examination (OR=2; C.I=1.4-2.7; p-value <0.0001). Experience of radiographer, physical built of the patient and sex of the patient was not found to be significant factor in the occurrence of positioning error in digital radiography. In the multivariable logistic regression model (Tab.3), protective effect of radiological examination performed by male radiographer was raised to 35% as compared to female radiographer with statistically significant difference

(p-value=0.01). Patient age, examination of parts of body other than abdomen and male sex of the patients remained highly significant factors responsible for film retakes by positioning error as compared to retakes by other technical errors (p-value <0.05).

Variables	AOR	95%CI	p-values
<b>Radiographer's gender</b>			<b>0.01</b>
Female	1		
Male	0.6	0.5, 0.9	
<b>Experience of Technology (years)</b>			<b>0.8*</b>
< 5	0.9		
≥ 5	1	0.7, 1.3	
<b>Patient age(years)</b>	<b>1.01</b>	<b>1.01, 1.02</b>	<b>&lt;0.001</b>
<b>Patient gender</b>			<b>&lt;0.001</b>
Female	1		
Male	1.9	1.3, 2.7	
<b>Status of Patient</b>			<b>0.39*</b>
Not able to Work	1		
Walking	1.08	0.5, 1.2	
<b>Type of Exam</b>			<b>&lt;0.001</b>
Chest / abdomen	1		
Others	2.03	1.7, 3.3	

AOR; Adjusted Odds Ratio  
CI; Confidence Interval  
p-value < 0.05 was statistically significant  
\*; variable is not statistically significant

**Table 3:** Multivariable analysis of logistic regression with radiographer and patients related characteristics' positioning error as an outcome variable.

## Discussion

Digital radiography is rapidly expanding yet conventional radiography will also be followed till the complete transition.<sup>9</sup> This might be one of the reasons for lack of massive training advancement in digital radiography in the presence of concurrent running of conventional system as some professionals still consider digital radiography only acceptable in high patient flow areas due to costly technology.<sup>10</sup> Nevertheless it has been agreed that digital radiography produce quick images and save times which is particularly commendable in accidents and emergencies as 30% of time reduction has been observed using digital radiography in the presence of radiology information system integration.<sup>11,12</sup> Thus training need issues may be original factor leading to other secondary factors responsible for high positioning error in digital radiography as pointed out by several studies.<sup>13</sup> Positioning error has been studied as a commonly

occurring error in digital radiography which causes frequent retakes. It has been established that positioning error may occur as a result of patient related factors as well as related to procedure or radiologist. However the reasons may vary in different places according to training availability and familiarity with the new technology.

In this study, factors responsible for positioning error were analyzed and revealed that higher proportion of errors occur while examining other body parts in digital X-ray radiography as compared to abdominal examination. They may link to the high skills requirement for examining different body parts as compared to abdominal examinations. Therefore training need for familiarity with new digital technology remains a priority need in many parts of the world.<sup>8</sup> Yet digital radiography is the main resort in chest radiology and other body parts where complete implementation of digital radiography has been achieved and facilitates in identifying many unseen lesions which could not be seen with the help of conventional radiograph.<sup>14</sup>

Furthermore increase in the age of the patient as a risk factor was observed which is particularly important while examining old age patients. Although it has been determined that patient satisfaction is greater in the digital system of radiography as compare to conventional system.<sup>15</sup> Yet examination of old age patient may become a difficult task in radiography and results in producing a significant errors which requires retakes. Another reason may include that additional imaging request has been increased over the period of time.<sup>16</sup> As a result of larger number of abnormal findings in old age patient, more retakes are requested which may increase the risk of positioning error. Hence age of the patient is another determinant to help in identifying the sources of positioning error in digital radiography and extra care in similar situations may help in reducing positioning errors.

Another major risk factor for positioning error was examination performed by female radiologist. This may be a particular a risk factor in this hospital setting of a developing country and needs further exploration. This study opens a channel for further studies like randomized controlled trials or educational training intervention on the issue of reducing positioning error in which intervention can be focused on the factors identified in this study. There are few limitations to this study as no equipment or technology related factors


were evaluated for film retake in digital radiography and no radiation dose associated with positioning retake was calculated, needs another longitudinal study to explore these issues.

## Conclusion

There are several patient and radiographer factors responsible for positioning error in digital radiography. The most significant patient's factors which were identified in our study were male sex of the patient and increase in the patient's age. Process related and radiographer factors included female sex of radiographer and examination of body parts other than chest and abdomen as the most frequently identified factors in our setting.

## References

1. Uffmann M, Schaefer-Prokop C. Digital radiography: The balance between image quality and required radiation dose. *Eur J Radiol.* 2009 Jul 21.
2. Tylen U. Digital chest radiography: clinical aspects. *J Digit Imaging* 1995; **8(1)**: 15-9.
3. Rong XJ, Shaw CC, Liu X, Lemacks MR, Thompson SK. Comparison of an amorphous silicon/cesium iodide flat-panel digital chest radiography system with screen/film and computed radiography systems: a contrast-detail phantom study. *Med Phys* 2001; **28**: 2328-35.
4. Korner M, Weber CH, Wirth S, Pfeifer K, Reiser M, Treitl M. Advances in digital radiography: Physical principles and system overview. *Radiographics.* 2007; **27**: 675-86.
5. Cruz R. Digital radiography, image archiving and image display: Practical tips. *Can Vet J.* Nov 2008; **49(11)**: 1122-3.
6. Tylén U. Stimulable phosphor plates in chest radiology. *Eur Radiol* 1997; **73**: 83-6.
7. Akhtar W, Aslam M, Ali A, Mirza K, Ahmad N. Film retakes in digital and conventional radiography. *J Coll Physicians Surg Pak.* Mar 2008;**18(3)**: 151-3.

- 
- 
8. Nol J, Isouard G, Mirecki J. Digital repeat analysis; setup and operation. *J Digit Imaging*. 2006 Jun; **19(2)**: 159-66.
  9. Neitzel U, Status and prospects of digital detector technology for CR and DR. *Radiat Prot Dosimetry*. 2005; **114(1-3)**: 32-8.
  10. Andriole KP. Productivity and cost assessment of computed radiography, digital radiography, and screen-film for outpatient chest examinations. *J Digit Imaging*. Sep 2002; **15(3)**: 161-9.
  11. May GA, Deer DD, Dackiewicz D. Impact of digital radiography on clinical workflow. *J Digit Imaging*, 2000 May; **13(2-1)**:76-8.
  12. Mattoon JS. Digital radiography. *Vet Comp Orthop Traumatol*. 2006; **19(3)**: 123-32.
  13. Peer S, Peer R, Walcher M, Pohl M, Jaschke W. Comparative reject analysis in conventional film-screen and digital storage phosphor radiography. *Eur Radiol*. 1999; **9(8)**: 1693-6.
  14. McAdams HP, Samei E, Dobbins J 3rd, Tourassi GD, Ravin CE. Recent advances in chest radiography. *Radiology*. Dec 2006; **241(3)**: 663-83.
  15. Dackiewicz D, Bergsneider C, Piraino D. Impact of digital radiography on clinical workflow and patient satisfaction. *J Digit Imaging*. May 2000; **13(2 Suppl1)**: 200-1.
  16. Siström CL, Dreyer KJ, Dang PP, Weilburg JB, Boland GW, Rosenthal DI, Thrall JH. Recommendations for Additional Imaging in Radiology Reports: Multifactorial Analysis of 5.9 Million Examinations. *Radiology*. 2009